LAYERED WEB SEALING AND SEVERING HEAD AND METHOD FOR USE THEREOF

BACKGROUND OF INVENTION

FIELD OF INVENTION

This invention relates to a head for sealing and severing two or more layers of a web and has application in sealing across a tube of thermoplastic film or other materials and separating the tube at the seal in order to form a series of containers.

DESCRIPTION OF THE RELATED ART

Sealing machines are used to package fluids, such as granular materials or liquids of various viscosities, from water to syrup in pouches. One type of package or pouch-making machine is a vertical form, fill and seal machine. With vertical form, fill, and seal machines, a heat sealable web material may be supplied from a roll. The flat web material may be unwound and formed into a vertically oriented tube which surrounds a fluid delivery device, such as a spigot. A sealing assembly may be located below the delivery device, sealing across the tube by heat pressing the two layers of web materials together through the use of a sealing head reciprocating toward and away from the tube opposite a backstop. Initially, a bottom seal may be made and a quantity of flowable material delivered to the tube. The tube may then be indexed downwardly, and another seal made above the bottom seal so as to form a pouch between the two seals. The second seal will also act as a first seal for the next-to-be formed pouch. Subsequent to the forming of a pouch, the pouch may be separated from the web by a knife.

FIG. 1 illustrates an exemplary vertical form, fill, and seal machine **100**, in which a flat web **112** of film is unwound from a roll **110** and sealed into a tube **114** surrounding a spigot **116** by a sealing head **118**. The spigot is used to deliver a fluid to the tube and a sealing jaw assembly **122** may then be used to seal and cut filled pouches **120** from the tube **114**. The filled pouches may be discharged from the machine onto a conveyor belt **130**. The film of the web may be made of a heat sealable flexible, light-weight material, such as a polyethylene/polypropylene laminate or other similar plastic materials. The speed of machine **100** may be increased if, rather than metering out a suitable volume

of fluid for each pouch before the upper seal to complete the pouch is formed, the tube **114** is filled above the level where the upper seal will be formed. A sealing device that forms a seal through a liquid-containing tube is disclosed in US6,178,724 to Tobolka.

In US6,178,724 to Tobolka the sealing jaw assembly comprises a sealing jaw with sealing heads and a backstop jaw that incorporates a knife which reciprocates between the heads.

Where a knife reciprocates between the sealing heads, the seals formed by the heads will be longitudinally spaced by an amount sufficient to accommodate the knife. For machines forming liquid filled pouches, this longitudinal space between the seals may trap liquid. A small amount of fluid trapped in this space will likely be converted to steam during the heat sealing operation, which may interfere with the proper formation of the seals. Furthermore, liquid trapped in this space might remain trapped even after severing of the web. Should this occur, the liquid, not being properly sealed in, may spoil; this is of particular concern if the liquid is intended for human consumption.

To avoid the noted drawbacks, the heads may simply seal pouches, and each pouch may be advanced in order to be separated at a cutting station downstream of the sealing heads. However, this approach has the drawback that care must be taken to ensure the seal between pouches is cut mid-way, so that the seal will be just as wide, and therefore just as secure, for the pouch below and above the cut.

Therefore, there remains a need for a rapid sealing assembly that will minimize a space between seals of adjacent containers.

SUMMARY OF THE INVENTION

A sealing head for sealing and severing a layered web has a knife and a supporting base. The supporting base extends, in the lengthwise direction of the knife, along opposite faces of the knife to partially envelop it so that the strip is immobily held by the supporting base and protrudes from the base. The supporting base has a lower thermal conductivity than that of the strip. The sealing head may be used on a sealing jaw assembly,

as for example, the sealing jaw assembly of a vertical form, fill, and seal machine. In use, the sealing head may be heated in order to, after a time, establish a baseline temperature in the supporting base which is sufficient to seal layers of the web together. The head may then be pressed against the web and the temperature of the knife momentarily spiked so that the web is severed by melting.

According to one aspect of this invention, there is provided a layered web sealing and severing head, comprising: a knife having a first thermal conductivity; a supporting base having a second, lower, thermal conductivity; said supporting base extending, in a lengthwise direction of said knife, along opposite faces of said knife so as to partially envelop said knife such that said knife is immobily supported by said supporting base and protrudes from said supporting base.

According to another aspect of the present invention, there is provided a sealing jaw assembly, comprising: a first jaw with a backstop; an opposed second jaw with a sealing head, said sealing head having: a strip having a first thermal conductivity; a supporting base extending along opposite faces of said strip so as to partially envelop said strip such that said strip is immobily supported by said supporting base and protrudes from said supporting base toward said backstop; said supporting base having a second, lower, thermal conductivity.

According to a further aspect of the present invention, there is provided a method of sealing and cutting a layered web, comprising: heating a sealing head comprising a knife having a first thermal conductivity protruding from a supporting base having a second, lower, thermal conductivity, to a baseline temperature, said baseline temperature sufficient to seal layers of said web together; pressing said sealing head against said web; and spiking a temperature of said knife above said baseline temperature so as to sever said web by melting.

Other features and advantages of the invention will become apparent from a review of the following description in conjunction with the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In the figures which disclose example embodiments of the invention:

FIG. 1 is a perspective view of a conventional vertical form, fill and seal machine discharging onto a conveyor belt a succession of sealed pouches.

FIG. 2 is a top view of a sealing assembly made in accordance with an embodiment of the invention.

FIG. 3 is the front view of a portion of the sealing assembly of **FIG. 2**.

FIG. 4 is a perspective view of a sealing head and a schematic view of a heating control circuit for the head.

FIG. 5 is a schematic end view of the sealing head of **FIG. 4**.

FIG. 6 is a side view of the knife of the sealing head.

DETAILED DESCRIPTION

A sealing assembly is employed to clamp together layers of a layered web, such as two layers of flexible laminate plastic film, and to bond and cut the layers by applying heat and pressure. In one embodiment of the invention, the sealing assembly includes a pair of jaws, one of which has a sealing head with a conductive knife protruding from a tapered dielectric supporting base. The knife has a high thermal conductivity relative to the supporting base. A current supplied through the knife heats it and the heat of the knife raises the temperature of the supporting base to a baseline temperature. When the head abuts the layered web, a spike current through the knife raises its temperature momentarily to melt through, and therefore sever, the web.

Turning to **FIG. 2**, plate **255** of an upper sealing assembly is joined to push rods **265**, **275**. A rack **266** extends from an end of each push rod, which end is joined to the plate **255**. Similarly, a rack **222** extends from the end of each of shafts **210**, **220**, which end is proximate plate **255**. Frame **212** supports two pinions **280**, **290**; each pinion meshes with

both a rack **266** of one of the push rods **265** or **275** and a rack **224** of one of the shafts **210** or **220**. When a motor **250** rotates a ball screw **260**, plate **255** is advanced toward frame **212**. The advancing plate **255** pushes the push rods **265, 275** to advance jaw **205**, which is bearing mounted on shafts **210, 220**, toward a tube film **200** and a jaw **215**. Advancement of the push rods causes the rack of each push rod to rotate the pinion that meshes with it (in a counterclockwise sense). Because each rotating pinion also meshes with a rack **224** of a shaft **210, 220**, the pinion pulls each shaft **210, 220**. Since jaw **215** is joined to shafts **210, 220**, the result is that the jaw **215**, which is also bearing mounted on shafts **210, 220**, is pulled toward the tube and jaw **205**. The stationary frame members **212** and **214** anchor the various moving assemblies of reciprocating upper jaws **205** and **215**.

The jaw **215** has a sealing head **222**. The jaw **215** acts as a back stop for sealing head **222** and may, for example, be fabricated of a high density plastic material. Although not show, the mechanism for reciprocating the jaws is repeated with a lower assembly.

Turning to **FIG. 3**, jaw **205**, with its sealing head **222** is seen in front view, along with a jaw **305**, and its sealing head **322** of a lower sealing assembly. A fluid delivery spigot **316** is shown here for delivering flowable material into the film tube **200**. Gripping fingers **318, 320, 324** may be provided to tension the tube **200**. The sealing head **222** of jaw **205** is detailed in **FIGS. 4** and **5**. The sealing head **322** of jaw **305** is identically configured.

Turning to **FIGS. 4** and **5**, sealing head **222** comprises a knife **410**, which is in the nature of a strip and a supporting base **412** extending along opposite faces **414, 416** of the strip such that the strip is partially enveloped, and immobily held, by the supporting base and protrudes from the supporting base. The strip may protrude about ten thousands of an inch (0.25 mm) from the supporting base. (The extent of the protrusion has been exaggerated in the figures for clarity.) It will be apparent from **FIGS. 4** and **5** that the supporting base tapers toward the point where the strip protrudes from the supporting base. The supporting base has two halves **418, 420**. Half **420** has a ledge **422** to abut the inner edge **424** of strip **410** and half **418** has a notch **426** to receive ledge **422** so that half **418** may be advanced toward half **420** sufficiently so that the strip **410** is sandwiched firmly between the halves. The halves of the support base may be bolted to jaw **205** by bolts **426**.

As seen in **FIG. 6**, the inner edge of strip **410** may have a series of notches. A terminal **430, 432** may be formed at either end of the strip **410**. Returning to **FIG.** 4, it will be seen that the terminals may be coupled to electrical wires to complete an electrical circuit generally indicated at **438**. The circuit may incorporate a larger electromotive force, battery **434**, and a parallel smaller electromotive force, battery **436**. One or other of the batteries may be coupled into the circuit by switch **440**. The default position of switch **440** switches the smaller battery **436** into the circuit. The switch may be provided by a solid state relay.

The strip **410** is fabricated of a material that has a higher thermal conductivity than the material of which the supporting base **412** is fabricated. Furthermore, the strip is an electrical conductor, typically a metal such as steel, possibly doped to increase its resistivity, whereas the supporting base is a dielectric, such as anodised aluminum.

A processor **270** (**FIG. 2**) may control motor **250** (**FIG. 2**) and switch **440**.

In operation, circuit **438** is completed and switch **440** left in its normal position to couple battery **436** into the circuit. This results in a current flowing through strip (knife) **410**. As the strip has a resistivity, the current heats the strip. Over time, the heat from the strip heats the partially enveloping supporting base **412**. The supporting base heats more slowly than the strip due to its lower thermal conductivity and the rate of this heat rise may be selected with the selection of its thermal conductivity. The processor **270** may maintain the sealing jaws **205**, **215** idle for a time sufficient to allow the supporting base to attain a baseline temperature. The size of battery **436**, and the resistivity of the strip **410**, may be chosen so that the baseline temperature is sufficient to seal layers of tube **200** together. The processor may then control motor **250** to advance the jaws **205**, **215** toward one another until they sandwich tube **200** between them. After a dwell time at a selected pressure, the heat of the strip and supporting base will form a seal across the tube. Thereafter, the processor momentarily switches switch **440** to couple the larger battery **434** into circuit **438**. This spikes the current through strip **410** causing the temperature of the strip to spike. The size of battery **434** is chosen so that the spike temperature is sufficient to melt through and sever the tube **200** in a short period of time -- e.g., 0.01 to 0.02 seconds. After this short period, the processor switches switch **440** back again, reducing the current in the strip, and thereby allowing it to cool back toward the baseline temperature. With a sufficient

difference between the relatively high thermal conductivity of the strip as compared with the supporting base, the strip will heat and cool relatively rapidly with little change in the temperature of the supporting base. In consequence, the temperature of the supporting base may be controlled to remain well below a temperature which would melt through the tube. With the tube severed, the jaws may withdraw, the tube may be indexed downwardly, and the process repeated.

The notches in the inner surface of the knife allow the width of the knife to be increased so that it may be held more securely by supporting base **412** without providing a current path along the strip which is deep with the support. Such a deep current path along the strip could heat the supporting base more rapidly than is desirable.

Due to the taper of the supporting base **412**, the pressure applied by the supporting base to the tube drops rapidly with distance from strip **410**. The reduced pressure results in lesser heat transfer to the tube. The consequence is that the tube is sealed along a selectably narrow band, dependent upon the degree of the taper and the dwell time.

Rather than forming supporting base **412** of two halves and sandwiching the strip **410** between these halves, the supporting base may be molded so as to partially embed the strip in the supporting base. In such case, the supporting base may be conveniently fabricated of ceramic.

Rather than employing two batteries and a controllable switch to heat strip **410**, any other controllable current source may be employed. This current source may generate direct current or alternating current.

Instead of heating strip **410** by passing current through the strip, the strip may be heated directly by a heater. In such case, the strip need not be electrically conductive, it would only be required that it have thermal conductivity higher than that of the supporting base.

While the knife has been shown as a plate-like strip, the knife could have other configurations. For example, the knife could be wedge-shaped.

While the head **222** has been described as used on a jaw of a vertical form, fill, and seal machine, the head has application in any situation where it is desired to seal and sever a layered web.

Other advantages and modifications within the scope of the invention will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.